3-5 GROUP COMPOUND SEMICONDUCTOR AND LIGHT-EMITTING ELEMENT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a 3-5 group compound semiconductor obtained by epitaxial crystal growth of a 3-5 group compound semiconductor on a GaAs substrate, and a light-emitting element using the same.

Compound semiconductors of this kind have a laminated structure of epitaxial crystal layers of 3-5 group compound semiconductor on a GaAs substrate, and for example, light emitting elements, which is widely used, have a laminated structure consisting of an $Al_{0.20}Ga_{0.80}As$ acting as a light emitting layer (active layer) and an $Al_{0.5}Ga_{0.5}As$ layer acting as a barrier layer (clad layer) on a GaAs substrate, to give red light emission. Optical devices of this kind have a characteristic that the overflow of injected electrons and halls is suppressed by large potential barrier owing to band gap discontinuity obtained by hetero junction, consequently, high light emitting efficiency can be attained. Though optical devices are exemplified for illustrations in the above, in addition to them, electronic devices such as HBT(hetero junction bipolar transistors) and HEMT(high electron mobile transistors) have also a laminated structure of epitaxial crystal layers of 3-5 group compound semiconductor on a GaAs

substrate.

When semiconductor devices having a laminated structure of epitaxial crystal layers on a GaAs substrate are produced, dislocation density in the epitaxial crystal layers becomes a problem. Namely, the dislocation density in the epitaxial crystal layers is closely related with device properties and reliability, and if the dislocation density is large, the quality of a produced device deteriorates problematically. For example, in the case of an optical device such as a light emitting diode, when the dislocation density is large, a problem occurs that lifetime and reliability of the device fall down simultaneously, and additionally, light emitting intensity also falls down.

The main cause of the dislocation occurring in an epitaxial crystal layer is based on a mechanism that, in a process of epitaxial growth, the dislocation originated in the GaAs substrate propagates into the epitaxial crystal layer.

Therefore, various methods for lowering dislocation density of GaAs substrate have been conventionally tried, such as a method of decreasing heat stress, namely, temperature gradient, in production of a GaAs substrate, a method of increasing critical shearing stress, and the like.

However, when the dislocation density of a GaAs substrate is tried to be lowered by the above-mentioned methods, manufacturing cost may become disadvantageous, further, there is a limitation to reduction of the dislocation, consequently,

it is difficult to raise the properties and reliability of devices to high levels.

SUMMARY OF THE INVENTION

The present inventors have made various investigations to solve the above-mentioned problems. Resultantly, it has been confirmed that the properties and reliability of an electronic device or optical device can be remarkably improved by growing 3-5 group compound semiconductors as a buffer layer on a GaAs substrate, and as an epitaxial crystal layer on said buffer layer, represented independently by the general formula $In_xGa_yAl_zAs$ (wherein, $0 \leqq x \leqq 1$, $0 \leqq y \leqq 1$, $0 \leqq z \leqq 1$, $x+y+z=1$), and by suppressing the dislocation density in the grown epitaxial crystal layer lower than the dislocation density in the GaAs substrate.

Firstly, the present invention is a 3-5 group compound semiconductor comprising a GaAs substrate, a buffer layer on said GaAs substrate and an epitaxial crystal layer on said buffer layer, said layers being formed by an epitaxial crystal growth method, wherein said buffer layer and said epitaxial crystal layer on said buffer layer are 3-5 group compound semiconductors each independently represented by the general formula $In_xGa_yAl_zAs$ (wherein, $0 \leqq x \leqq 1$, $0 \leqq y \leqq 1$, $0 \leqq z \leqq 1$, $x+y+z=1$), and the dislocation density in the epitaxial crystal layer on said buffer layer is $2000/cm^2$ or less.

Secondly, the present invention is a 3-5 group compound